

The extended language network: Language-selective brain areas whose contributions to language remain to be discovered

Agata Wolna, Aaron Wright, Benjamin Lipkin, & Evelina Fedorenko

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INTRODUCTION

Neuroimaging evidence converges in showing that language processing engages a **left fronto-temporal network** in the brain and the right homotopic areas [1, 2]

However, other **cortical, sub-cortical, and cerebellar** brain areas have been identified in studies on language processing [3-5]

- Language is studied using diverse tasks and paradigms
- Some of them might not effectively isolate language from task-related processes [6]

The **language localizer task** is an extensively validated paradigm which allows for the identification of the language network in individual brains, using a broad and robust contrast [7]

Research question

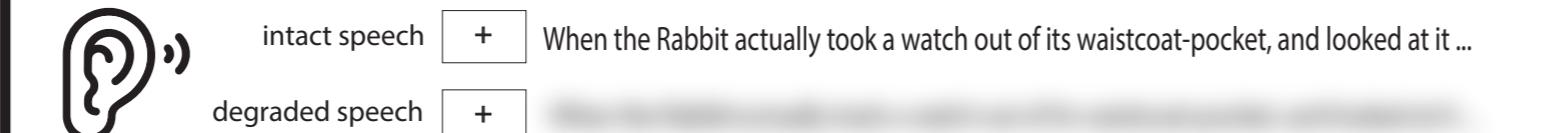
Are there any brain regions, beyond the fronto-temporal network, that reliably and selectively respond to language?

METHODS: design

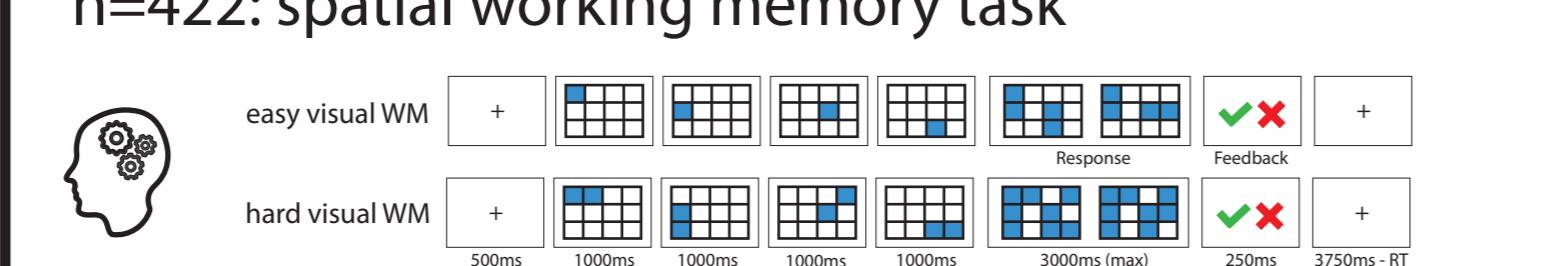
722 participants, multiple fMRI experiments
n=706: reading language task



n=86: auditory language task



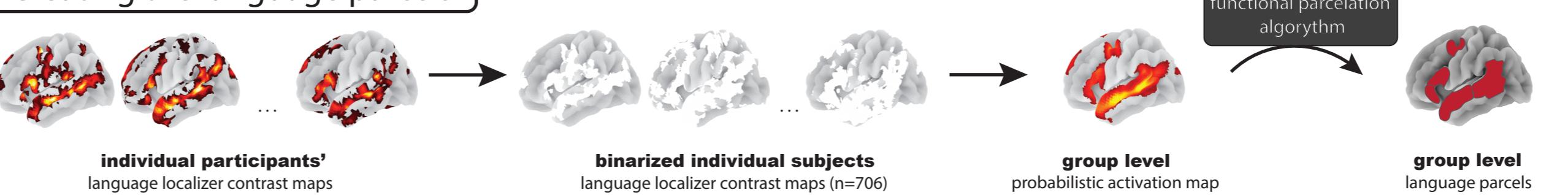
n=422: spatial working memory task



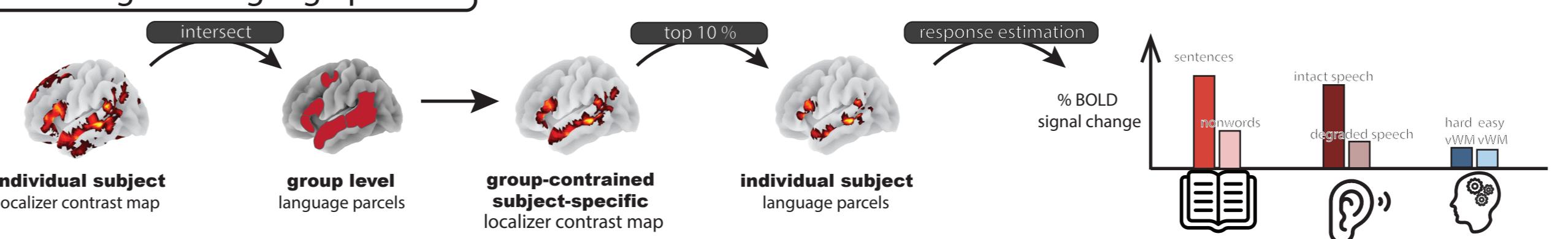
METHODS: analytical approach

Group-constrained subject-specific (GSS) approach [7]

Creating the language parcels



Creating the language parcels



MEET THE AUTHORS!



Aaron Wright

1st-year post-bacc in the BCS Research Scholars Program and an RA in EvLab. Interested in language and bilingualism



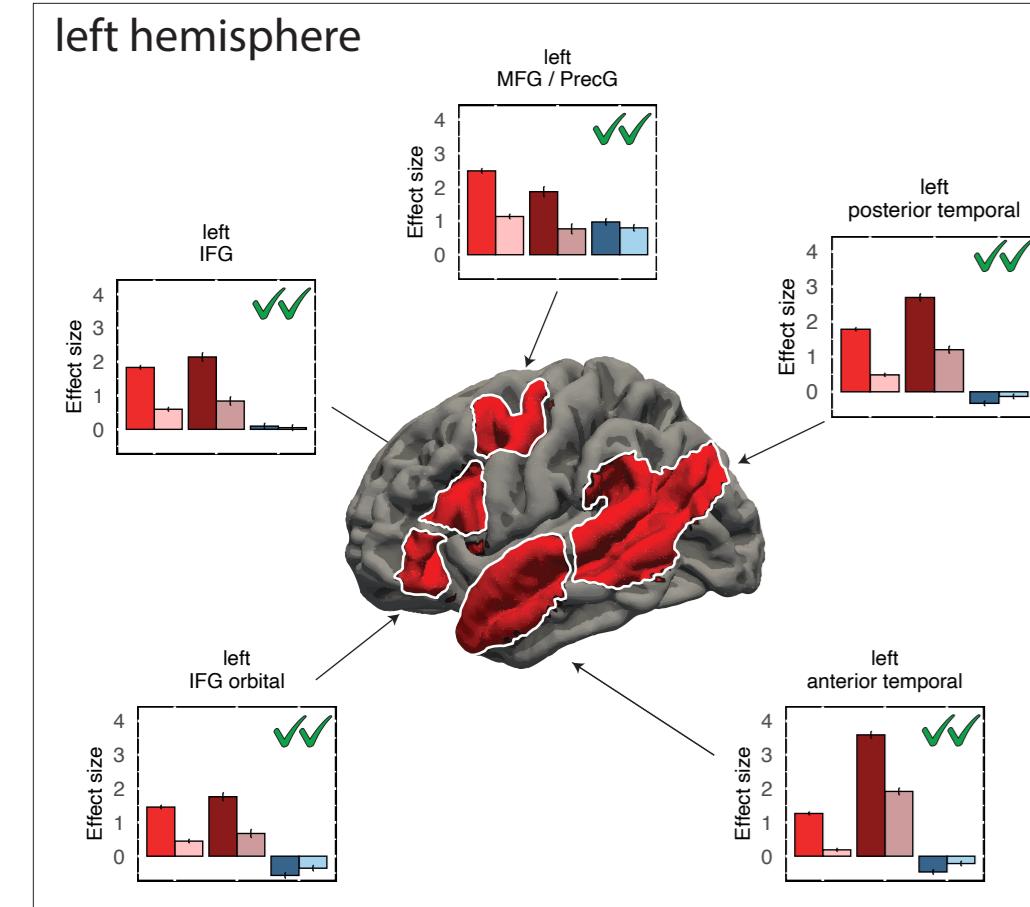
Agata Wolna

Post-doc in EvLab. Interested in brain organization of language and its relationship to speech perception and articulation



RESULTS: GSS language parcels

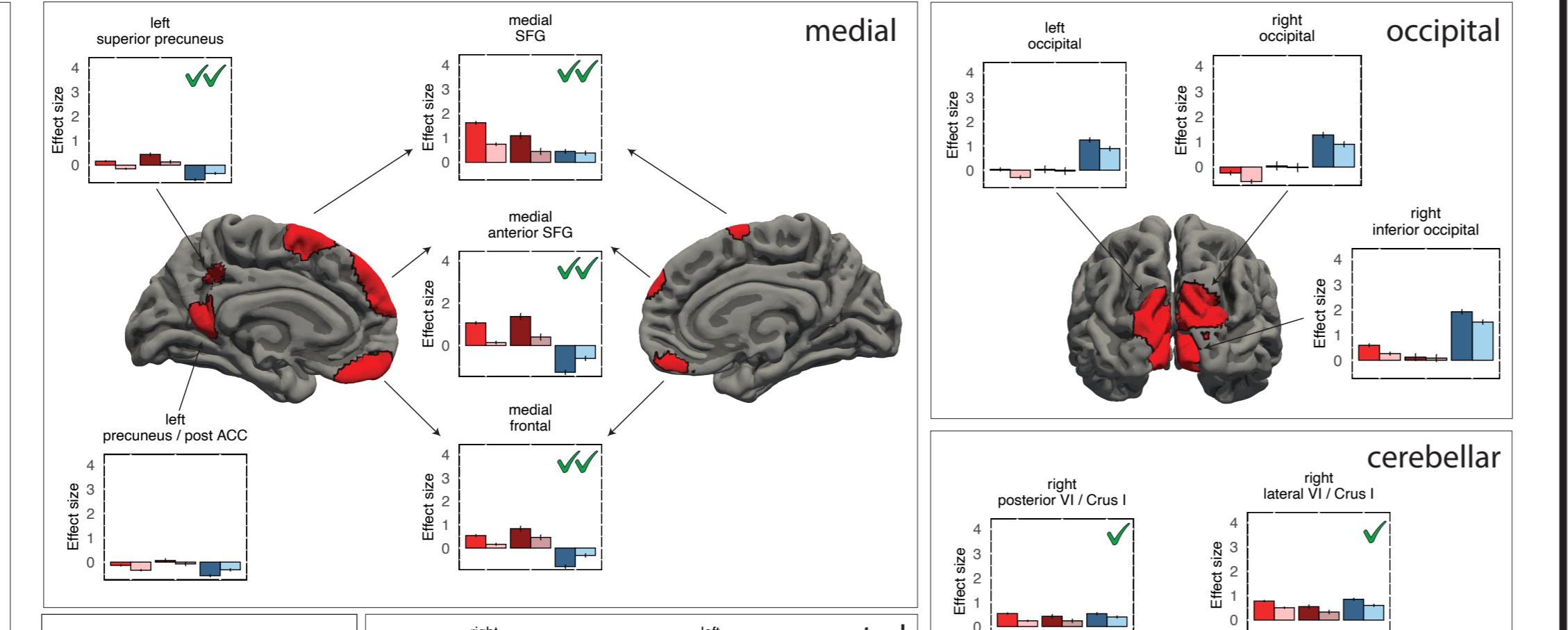
(A) Core fronto-temporal parcels



right hemisphere



(B) Extended parcels



Legend:

- Sentences
- Nonwords
- Intact speech
- Degraded speech
- Hard visual WM
- Easy visual WM

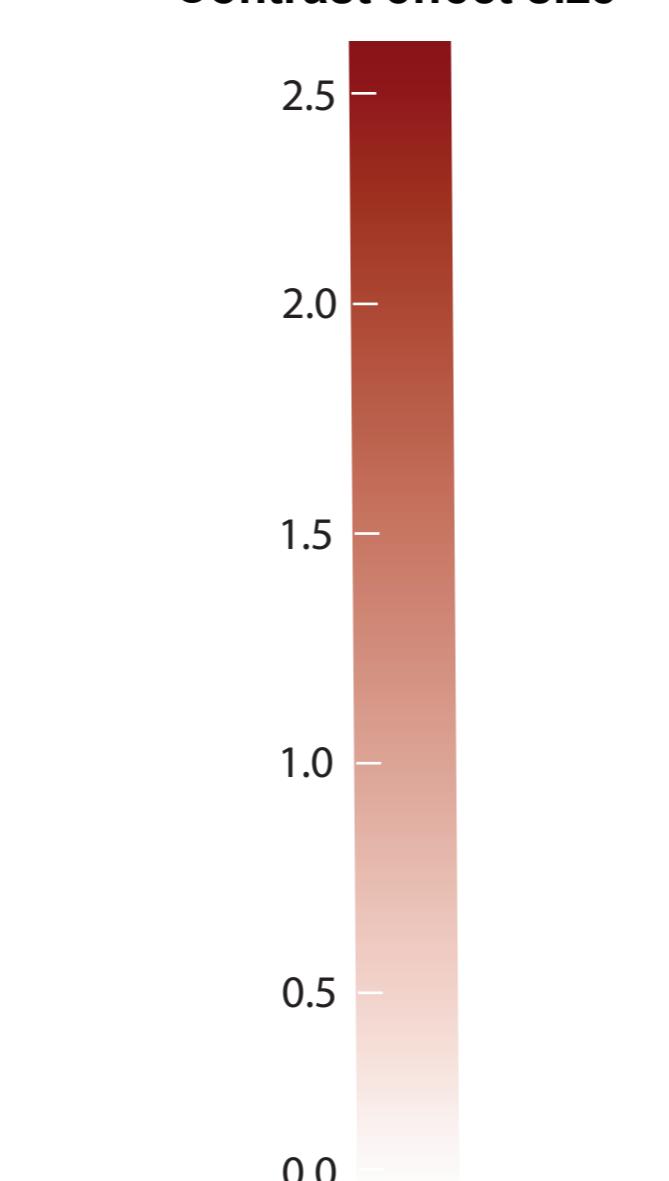
- ✓ language-selective
- ✓ language-responsive

20 language-selective parcels

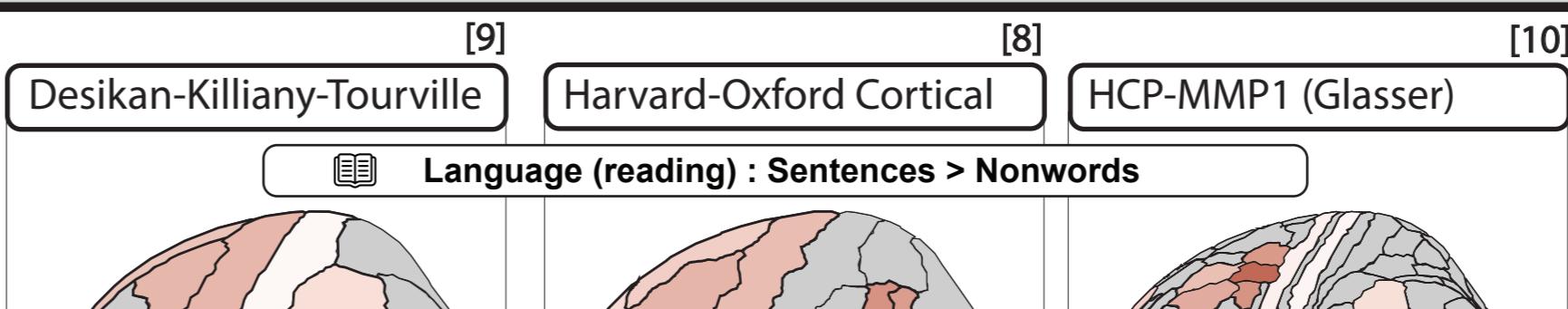
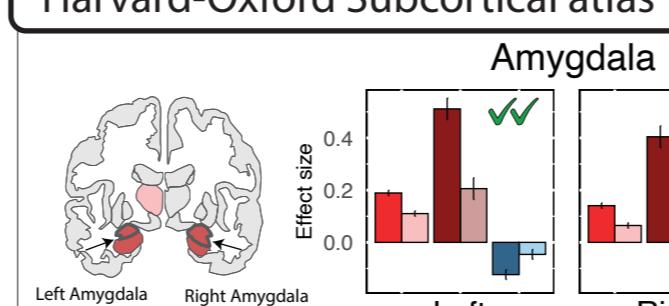
22 language-responsive parcels

Standard atlases

Contrast effect size



Harvard-Oxford Subcortical atlas



SUMMARY

1 The functionally-defined GSS language parcels and anatomical atlases provide converging results:
language selectively engages:
core lateral fronto-temporal regions

2 We also find language-selective responses in:
left medial frontal, ventral temporal, and cerebellar regions

as well as subcortically in:
bilateral amygdale and hippocampi

3 There are additional language regions that respond to language, **although not selectively!**
left thalamus, right cerebellum

These regions may also be important to understand language in the brain!

? mixed selectivity → integrating information across cortical networks

4 Although widely distributed, at the individual level the language system takes up <1.5% of the brain ... which equals the size of a large strawberry

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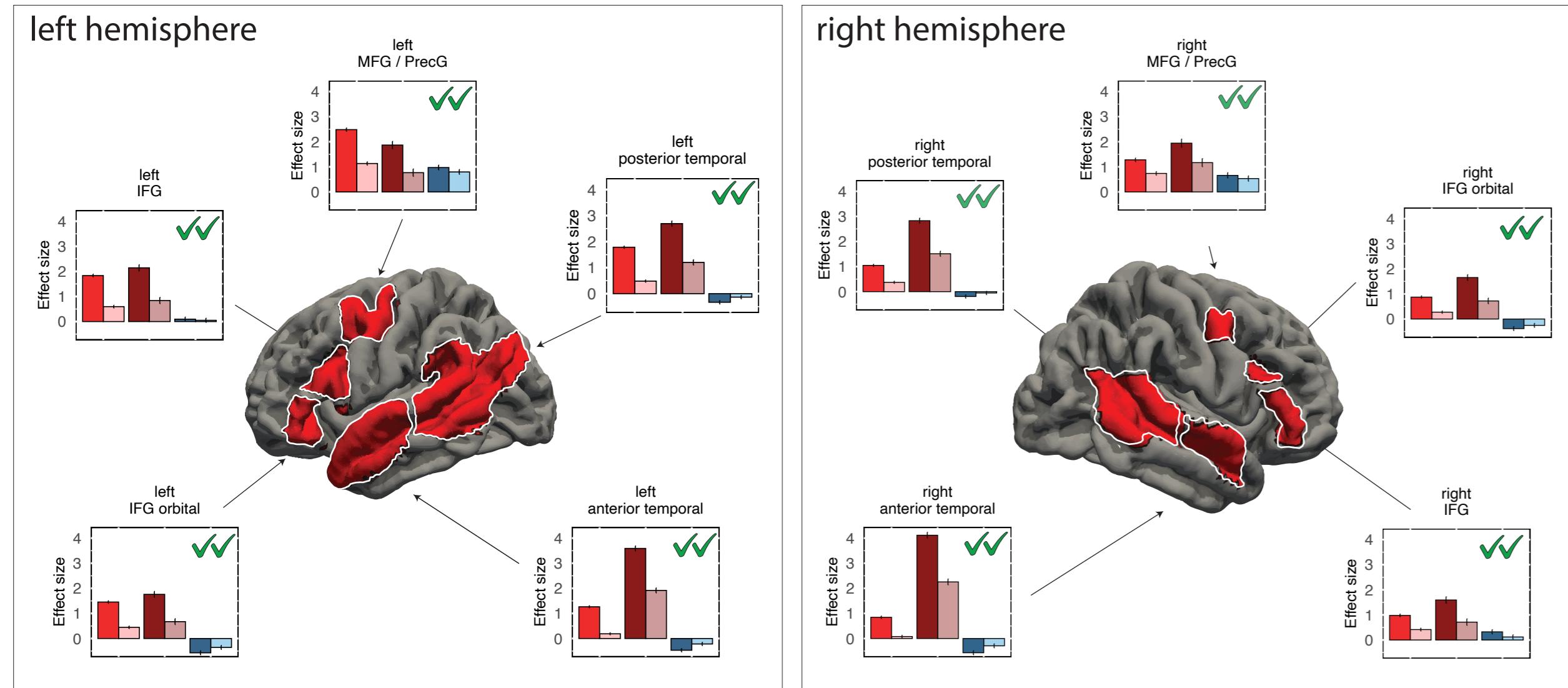
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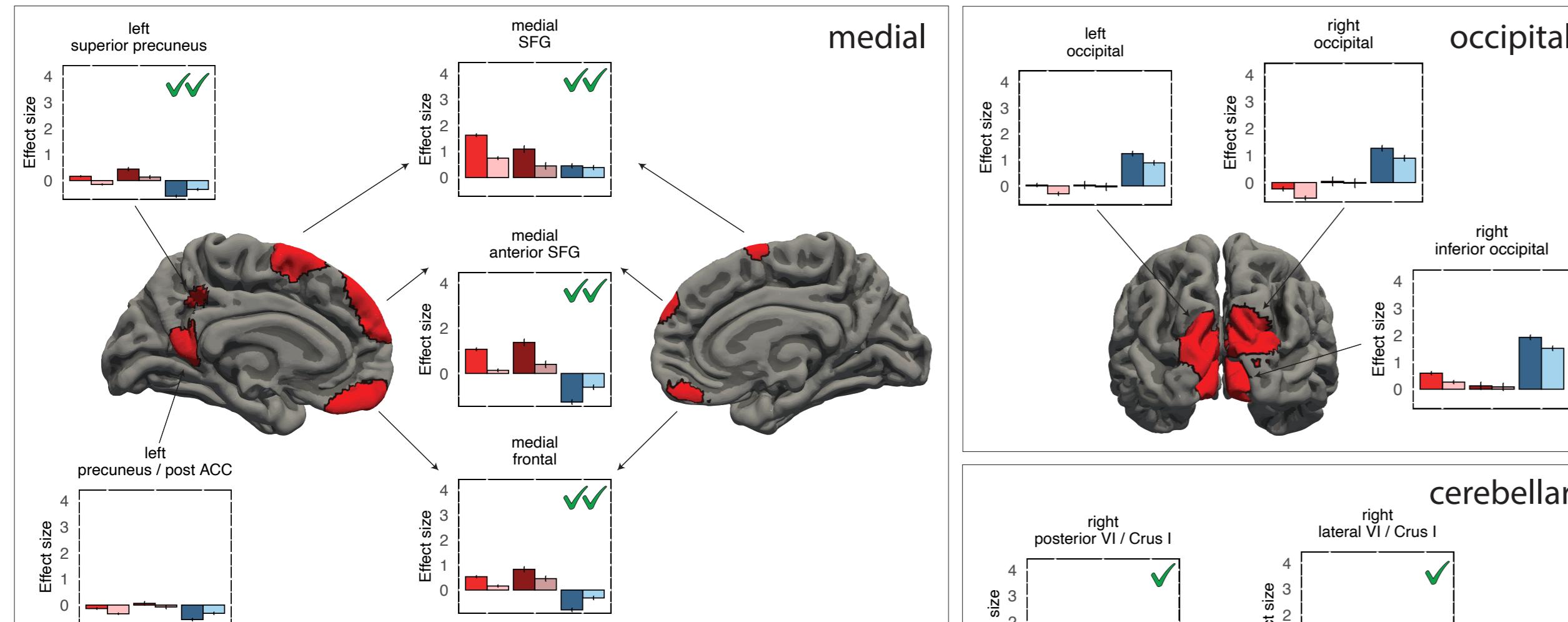
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RESULTS: GSS language parcels

(A) Core fronto-temporal parcels



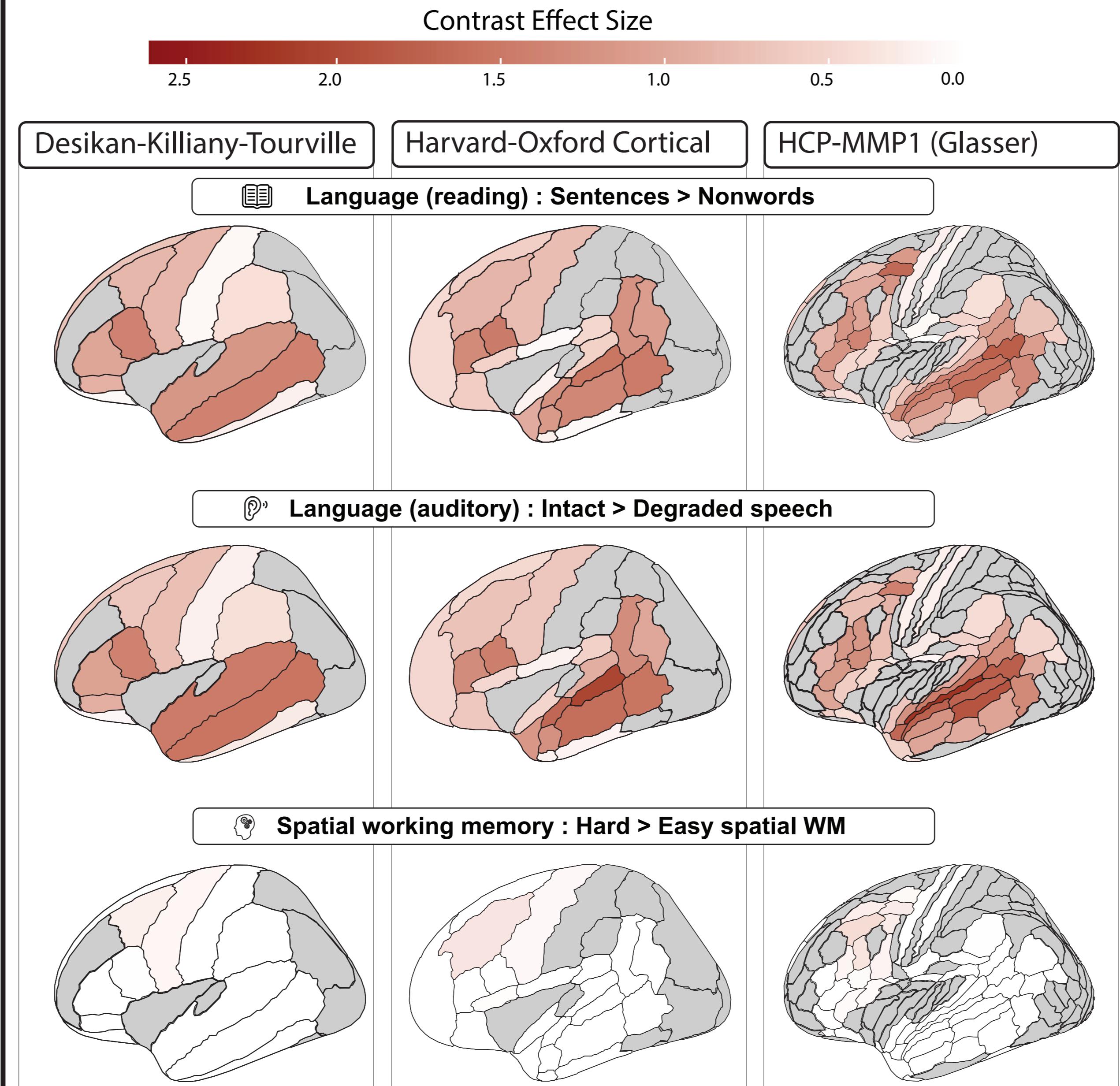
(B) Extended parcels



Legend:

- Sentences
- Nonwords
- Intact speech
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- Hard visual WM
- Easy visual WM
- ✓ language-selective
- ✓ language-responsive

RESULTS: standard cortical atlases



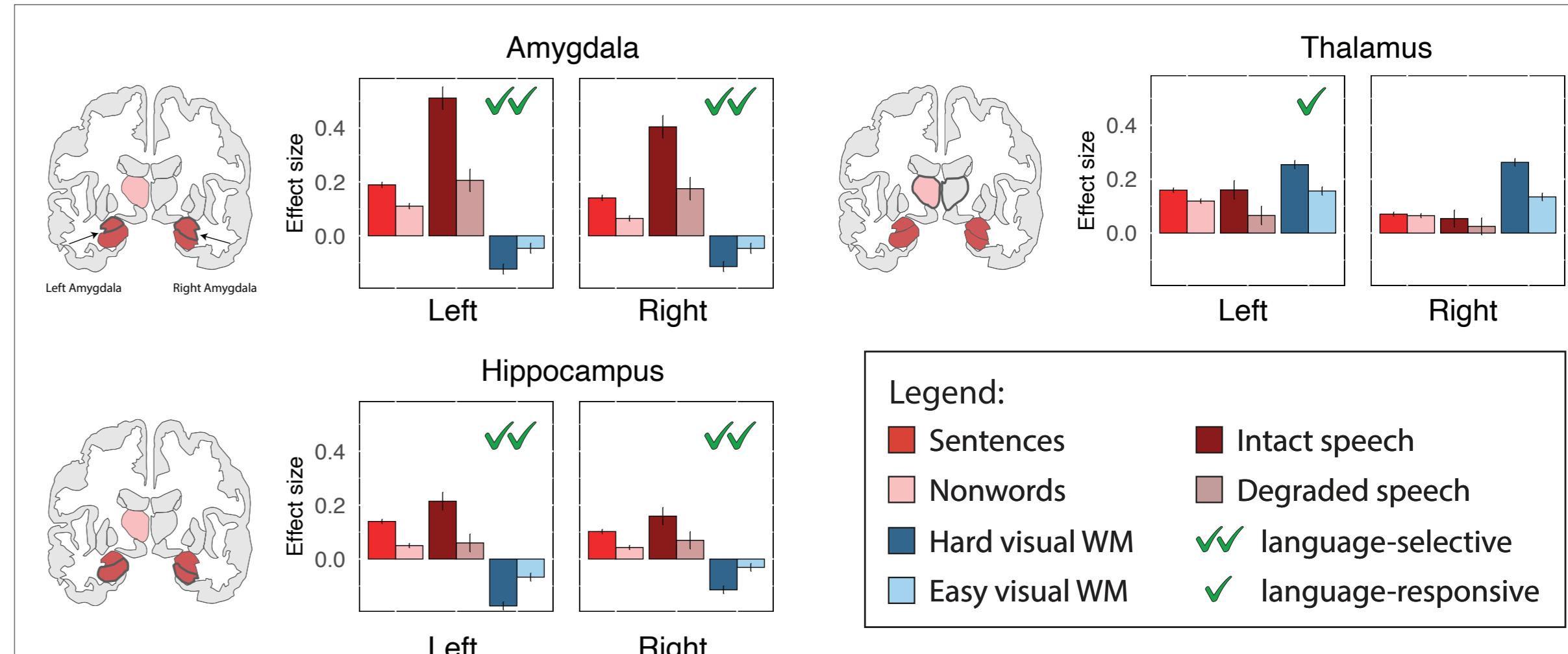
Coarse, anatomy-based parcellations are not well-suited to study language: language processing in the brain **does not “obey” anatomical boundaries**

Function-based parcellations, like GSS and some standard parcellations (including Glasser but also atlases based on functional connectivity, e.g., Shain et al., 2025), **provide a better window to study language in the brain**

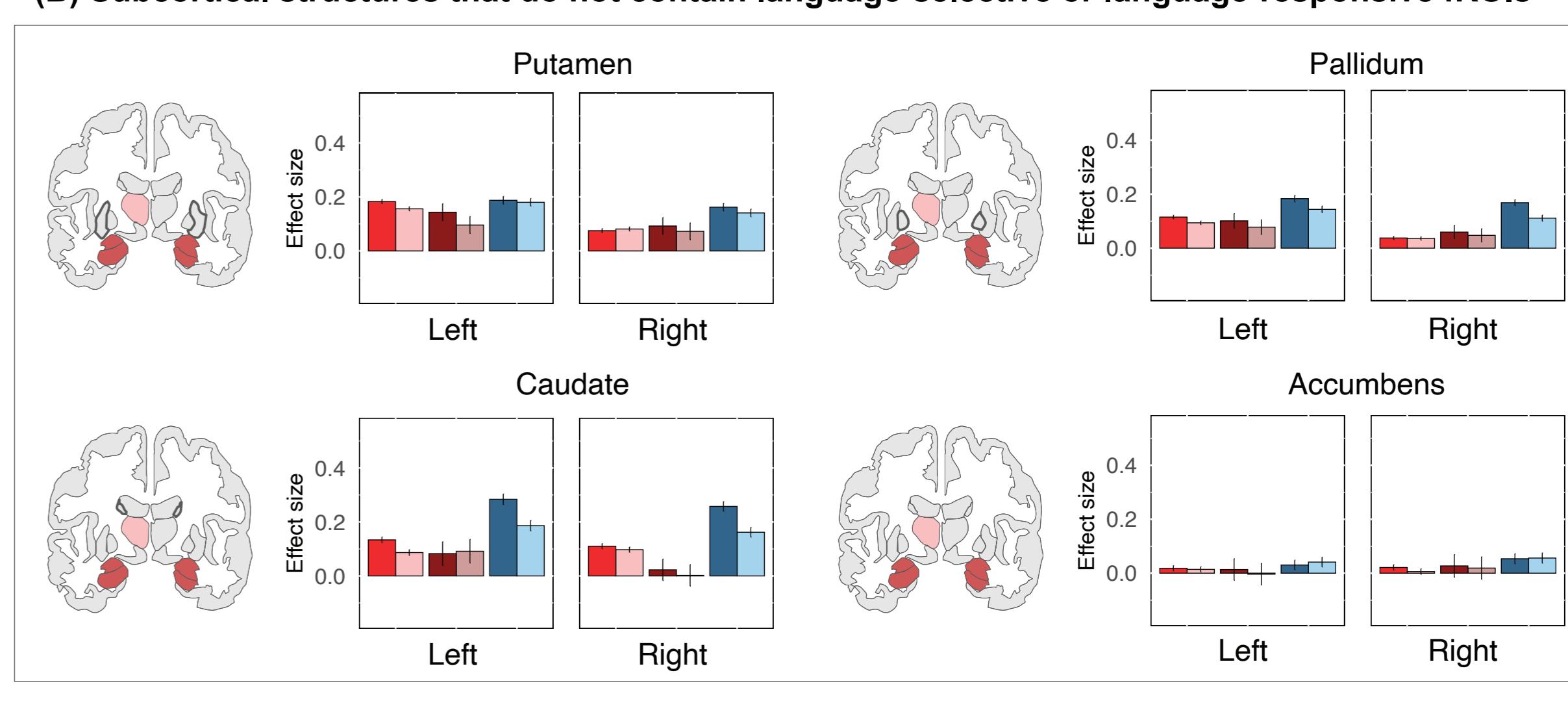
! Regardless of the group-level parcellation used, **language responses** should always be studied using **subject-specific, functionally localized regions!**

RESULTS: subcortical responses

(A) Subcortical structures that contain language-selective or language-responsive fROIs



(B) Subcortical structures that do not contain language-selective or language-responsive fROIs



Challenging previous claims, we find **no responsiveness to language** (amodal response to both reading and auditory language processing) in **basal ganglia and occipital cortex**

? In previous reports, language processing might be conflated with domain-general task, and attentional demands

! Not all language paradigms are well-suited to identify language-selective brain regions!